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Pregnancy and lactation in a bottlenose dolphin (*Tursiops truncatus*) may require a re-evaluation and adjustment of its diet to ensure that the additional nutritional requirements of reproduction are met. Kcals, fat, protein, and calcium are some important factors to integrate into the development of a diet for an animal that is pregnant or lactating. Fish species that make up the diet of the bottlenose dolphin vary in nutritional content. Recent studies at our facility show the following calcium content (in mg/100g) of fish and squid: mackerel = 580 (S.D.=107, n=10), herring = 476 (S.D.=101, n=9), Columbia river smelt = 303 (S.D.=33, n=3), capelin = 379, (S.D.= 84, n=5), silver smelt = 577 (S.D.=78, n=6), and squid = 20 (S.D.=2, n=2).

Usually, nutrition studies involve depriving an organism vitamins or nutrients, and then examining the effect. This type of study is incompatible with marine animal training practices. Instead, we can assess nutrient requirements by collecting complete and accurate diet records on each of our animals, and infer nutrition requirements based on this healthy population. Because dietary requirements have been shown to vary in relation to species, age, and reproductive status, nutrition records should include these variables. Diets may also be related to other factors like water temperature, metabolic rate, and activity level, so these data should be recorded as well. As with any value, confidence levels increase as the sample size increases.

Very little is known about dietary requirements for non-commercial animals. In recent studies with bottlenose dolphins at our facility, dietary intake patterns for dolphins during pregnancy, lactation, growth and maintenance were examined. Subadults required an average of 53-81 Kcal/kg body weight; adults, 34-67 Kcal/kg; pregnant females, 36-89 Kcal/kg; and lactating females 88-153 Kcal/kg. Intake decreased with age in non-pregnant, non-lactating dolphins.

Calcium is important for proper nerve and muscle function, integrity of bone and teeth, and normal blood coagulation. Mammals not receiving adequate levels of calcium suffer from stunted growth and skeletal dysfunction. Calcium deficiency may result in rickets in young animals and osteomalacia which may be accompanied by spontaneous bone fractures in older animals. Calcium

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requirements for marine mammals are unknown. However, data is available for other mammals in regards to calcium demands during pregnancy and lactation. Rats are affected adversely if they receive calcium deficient diets during lactation and the late stages of gestation. About 99% of the calcium in an animal's body is found in the bones and teeth. Elaborate physiological controls work to maintain a constant calcium concentration in the plasma. Vitamin D in proper amounts is also necessary for the absorption of calcium. If inadequate amounts of calcium are ingested by a late term or lactating female, calcium will be absorbed from the bone to maintain a constant level in the blood. That is why blood serum calcium concentration is not a direct reflection of total body calcium. However, it may provide important information if it is carefully monitored over months or weeks.

Lactation for most mammals requires a greater intake of calcium. If calcium intake is inadequate to meet the demands of lactation, clinical problems may develop. If too much calcium is fed in the few months prior to parturition, the elaborate physiological controls in the body that work together to metabolize calcium including the parathyroid gland, vitamin D, and serum calcium levels, can become "lazy" and unable to gear up fast enough to meet the high demands of lactation. This could result in a condition known as "milk fever" which is well recognized in cattle. While its occurrence in cattle is common, it has a low mortality rate. However, were it to occur in dolphins, the weakness associated with it could result in drowning. Too much calcium can also cause a reduction of the absorption and utilization of other minerals.

So, the question is how much and what kind of fish should be fed to a pregnant or lactating dolphin? And, do dolphins in the wild adjust their diets during gestation and lactation? Bernard and Hohn (1989) studied stomach samples of spotted dolphins, *Stenella attenuata*, that were killed incidentally in tuna nets. They found that the diet of lactating dolphins was much different from that of pregnant dolphins which was similar to the diet of the general population. Pregnant dolphins ate more squid than did the lactating dolphins who ate more fish, in particular, flying fish. How could this change of diet reflect changes in the dietary requirements of pregnant and lactating dolphins? One explanation is food energy. In a study done at our facility, dolphins increased their intake during lactation by as much as 204% over the period preceding conception, while intake increased only slightly during the latter stages of gestation. Flying fish is higher in kcals and protein and would therefore provide more food energy than squid. Ridgway (1972) also points out that by switching to a diet of fish, lactating dolphins help prevent additional water loss due to the higher levels of sodium and chloride in squid diets. It has been suggested that since squid are vertical migrators perhaps fishing for squid would necessitate a lactating dolphin to leave her calf to catch food, or reduce her feeding success rate. This suggests that it would be easier to catch fish that can be found near the surface of the ocean. There is no evidence to support this theory. However, fish would provide a lactating

bottlenose dolphin with more calcium and phosphorous, the demand for which is probably increased during lactation.

Fish species vary in their nutrient content, and there is variation within a fish species depending on where and when it was caught, as well as other factors. Kcals can be determined by proximate analysis. At our facility we have been looking at the calcium content of fish to see how and if it varies between and within species. To do this, six species of fish and squid were measured for weight and length and sexed. A total of 35 samples have been analyzed. Although it is preliminary, there seems to be a difference in the calcium content of different species of fish. Silver smelt and mackerel averaged the most, Columbia river smelt was the fish that showed the lowest average, and squid was much lower than any of the fish. Although these averages may not appear to be that different, remember that this value is in milligrams per 100 grams of fish. If you multiply it out for the daily intake, or for the monthly intake, it begins to take on more obvious significance. The difference in the calcium averages of each species of fish should be taken into account when developing longterm diets for pregnant and lactating dolphins.

So how should we determine diets for pregnant and lactating bottlenose dolphins? Most likely it is only during the last trimester of gestation that there is a requirement for a slight increased intake of Kcals. Gradual increases in food would more likely result in a more consistent diet. The diet should include a variety of fish (they eat a variety in the wild). It is probably safe to assume that lactating dolphins require more calcium during lactation. We already said earlier that they need more Kcals. If a dolphin's diet during gestation is proportionately increased as it goes from gestation to lactation, the animal will get both more Kcals and more calcium. It is important to make sure that the diet is not changed to result in a lower amount of calcium. Calcium supplements are probably not necessary for an animal that is getting a diet that includes a variety of fish¹. And, of course, the accurate food and health records that we maintain will help us develop diets in the future.

¹While we feel this statement is correct, we empirically supplement our lactating dolphins with 3000 mg of calcium administered once a day. Other facilities have done this in the past with no adverse effects noted. In the meantime, we continue to evaluate calcium intake in lactating dolphins, and calcium content of various fish species.

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